

SOME SYNOPTIC ASPECTS OF THE HOT WEATHER IN CALIFORNIA, MAY 29-31, 1950

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During the last 3 days of May 1950, temperatures in the inland sections of California rose to near record levels for the season. At most reporting stations the highest was reached on May 30 though some points in the southern portion of the State reported higher temperatures on the 31st. Figure 1 shows the maximum temperatures on each of the last 3 days of the month together with the 24-hour change in maximum temperature for each day. The highs of 108° F. at Red Bluff, 106° at Bakersfield, and 100° at Sacramento compare with absolute maxima for May of 110°, 110°, and 103°, respectively.

Hot weather extended to the coast only at San Francisco, where the highest temperature was 92°, reached on May 29. Although this is 5° below the May record of 97°, it is far above the average maximum temperature of 63°. The sectional weather charts in figure 2 show the westward extent of the warm air at 1030 PST, and 1130

PST, May 29, when the temperature at San Francisco rose from 79° at 1030 PST to 91° at 1130 PST. By 1530 PST (chart not shown), the temperature had dropped to 84°. On May 30 the cool sea breeze advanced almost to Sacramento and temperatures in the San Francisco Bay area dropped to near normal levels (fig. 1).

The following paragraphs present some of the synoptic aspects leading to the establishment and breakdown of this high temperature situation of May 29-31, 1950.

At 0030 GMT, May 28 (chart not shown), a rapidly deepening Low in the North Pacific had moved north-eastward to a position near 49°N, 153°W. As this Low deepened and extended to higher levels in the atmosphere, winds aloft in the area south and east of the Low backed to southwesterly and increased in speed. On the 500-mb. chart for 0300 GMT, May 28 (fig. 3) this area of strong southwesterly winds aloft is shown as a broad band ex-

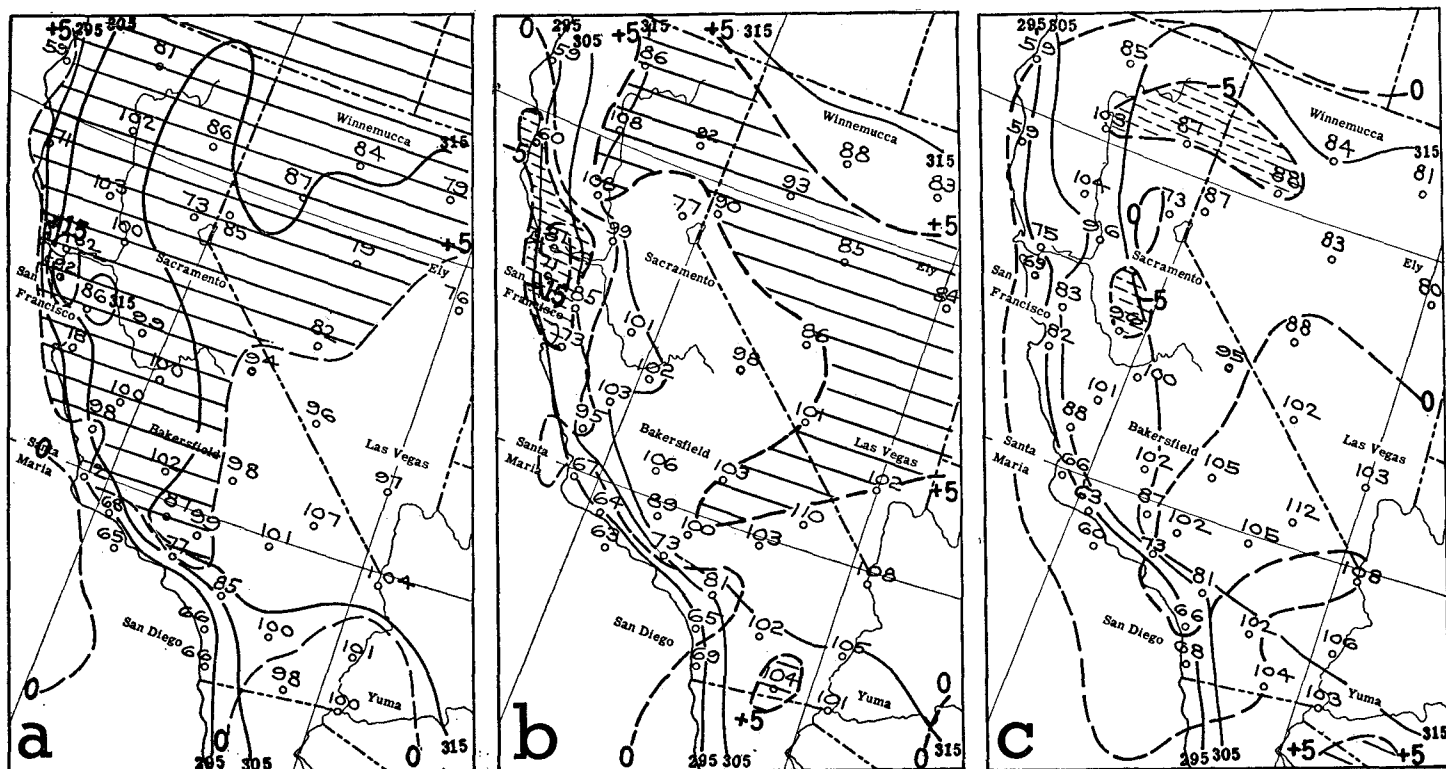


FIGURE 1.—Maximum potential temperature charts for (a) May 29, (b) May 30, and (c) May 31, 1950. Solid lines are isotherms of the potential temperature (in degrees absolute) of reported maxima. Broken lines show 24-hour change in maximum temperature (in degrees Fahrenheit). Solid hatching covers areas of 5° F. or more of 24-hour warming and broken hatching areas of 5° or more of 24-hour cooling. Actual reported maximum temperatures (in degrees Fahrenheit) are shown at individual stations.

tending approximately from 160°W to 145°W , and between latitudes 40°N and 50°N . Contour gradients indicate that wind speeds in this area were 80 to 100 knots.

East of the area of strong southwesterlies at 500 mb. (fig. 3) there was a marked north-south temperature gradient north of latitude 45°N . The accompanying warm advection in the current approaching the coast from northern California to British Columbia indicated rising contour heights in the vicinity of the Washington and British Columbia coastal area. Also, as shown in figure 3, a west-northwest wind of about 50 knots in southwestern Oregon was moving toward an area of appreciably weaker gradient in northern Nevada. This movement into weaker gradient required supergradient flow over northern Nevada (assuming eastward movement of the contour system to be less than the wind speed), and consequently a change

to more anticyclonic curvature. The result was a shifting of winds over Nevada to more northerly. To the west of southern Oregon, over the Pacific, the contour gradient (fig. 3) indicated that winds of 50 knots or better should have continued to be fed into southwestern Oregon until there was an appreciable change in the contour pattern. Assuming this condition to hold through a reasonably deep layer of the atmosphere, any continued anticyclonic turning of successive streamlines from southwestern Oregon through Nevada should have tended to carry mass across the contours and eventually to produce a contour gradient more nearly corresponding to the flow.

To the southward, a similar condition of strong winds flowing into an area of weaker gradient is indicated on figure 3 where winds 300 or 400 miles west-northwest of the northern California coast are moving into the weaker

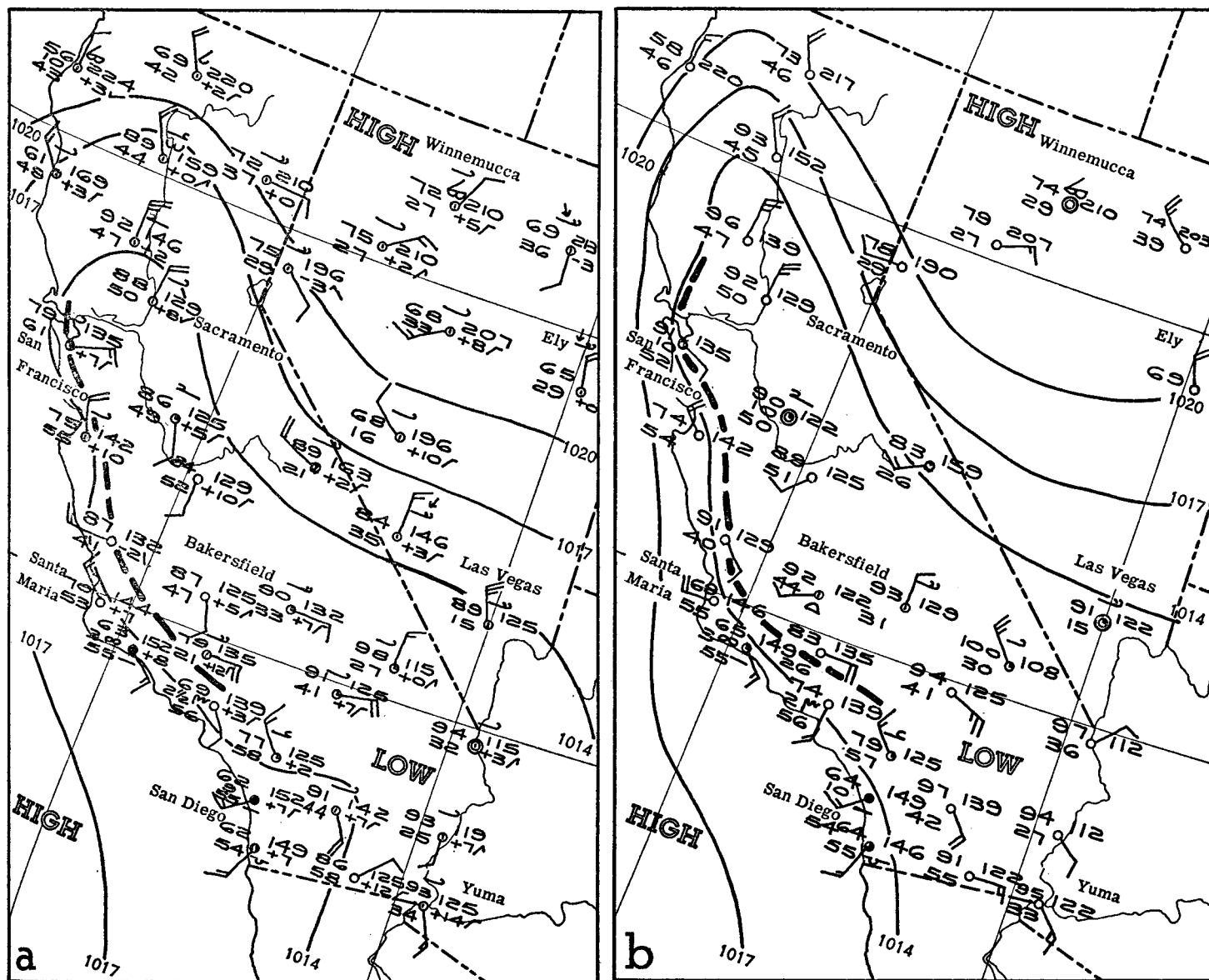


FIGURE 2.—Sectional surface weather charts for (a) 1030 PST and (b) 1130 PST, May 29, 1950. Heavy dashed line shows western boundary of warm air.

gradient over northern California. Existence of the stronger winds was less certain than over southwestern Oregon, but seems to be required by any reasonable interpretation of all available data. Thus conditions were favorable for winds over both California and Nevada to become more northerly during the ensuing 12 hours, as was verified by reports of generally northwest winds for 500 mb. at 1500 GMT, on the 28th (chart not shown). The shifting of direction continued, and at 0300 GMT on the 29th (fig. 4), 500-mb. winds over both States were almost straight northerly. Heights had risen at Tatoosh Island, Wash., and fallen slightly at Ely and Las Vegas, Nev. It should be noted that the northerly winds over California and Nevada were entirely in the warm air and that the strong north-south temperature gradient (in a band extending generally westward from Central British Columbia on fig. 4) was even farther north than its position 24 hours earlier.

Figure 4 also shows a broad band of strong westerly to southwesterly winds, located at that time west of Washington and British Columbia. As the southern portion of this westerly flow entered the weaker pressure gradient over the continental area it continued to turn anticyclonically. A small portion of the anticyclonic flow eventually arrived over California as a light northeasterly wind. The northeasterly flow was reported over the central and southern portion of the State 12 hours after the time of figure 4. At the same time, the upper High over the Pacific was increasing in intensity and was moving northeastward as indicated by the sharp ridge along the California coast.

It is of interest to note that this change of curvature to more anticyclonic along the trajectory (especially in

the northerly current) indicates horizontal divergence, by the principal of conservation of vorticity. There was a similar change of curvature at levels below 500 mb. (not illustrated). Appreciable divergence in the lower levels was necessarily accompanied by subsidence, an important factor in producing high surface temperature when combined with strong insolation at the ground. Some further subsidence at lower levels took place in air which reached the Great Valley of California, because of downslope motion on the lee side of high mountain ranges.

The surface weather chart for 0030 GMT, May 29 (fig. 5) shows a deep Low located off the coast of Southeast Alaska and a cold occlusion just entering British Columbia. Subsequently this front moved rapidly eastward in accordance with strong westerly flow aloft. There was, however, little southward movement of the cold air;

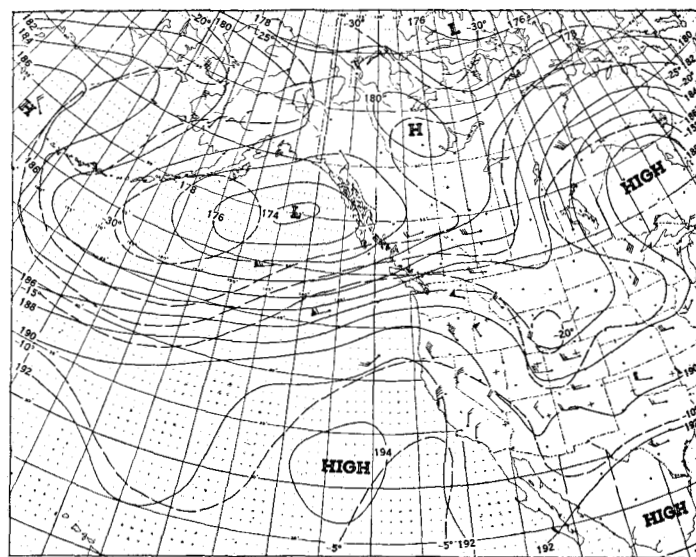


FIGURE 4.—500-mb. chart for 0300 GMT, May 29, 1950.

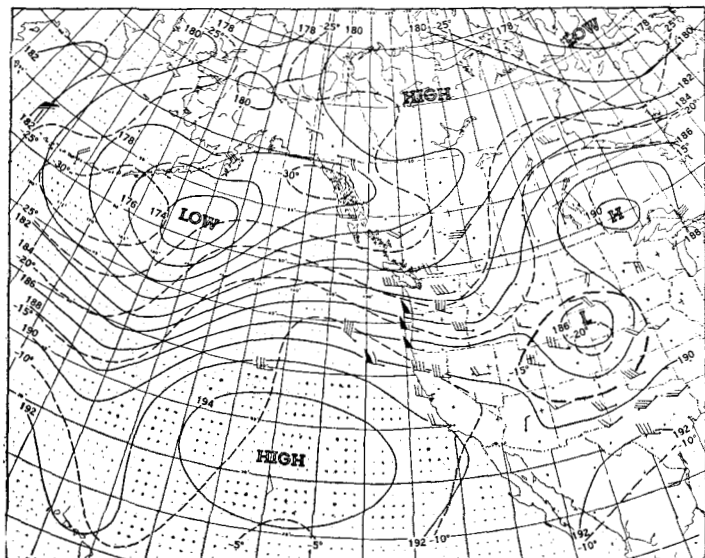


FIGURE 3.—500-mb. chart for 0300 GMT, May 28, 1950. Contours (solid lines) at 200-ft. intervals are labeled in hundreds of geopotential feet. Isotherms (dashed lines) are drawn for intervals of 5° C. Barbs on wind shafts are for wind speeds in knots (full barb for every 10 knots, half barb for every 5 knots and pennant for every 50 knots).

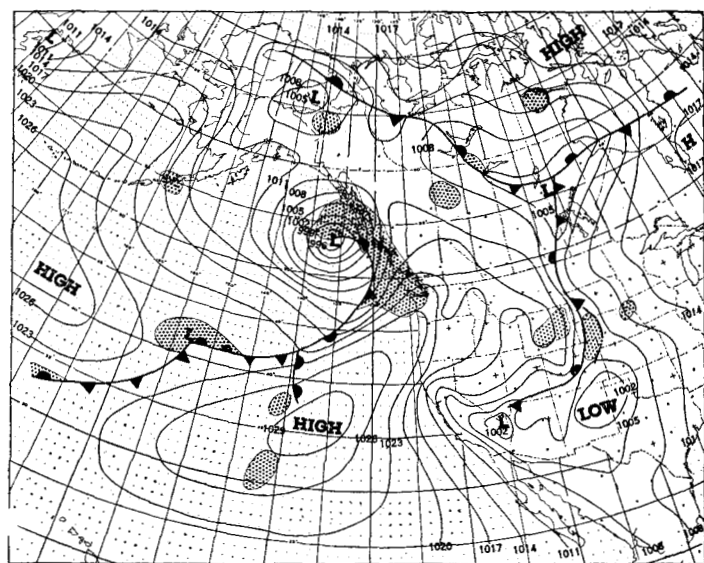


FIGURE 5.—Surface weather chart for 0030 GMT, May 29, 1950. Shading indicates areas of active precipitation.

the portion of the cold front which later trailed westward became stationary and by 0030 GMT May 31 (chart not shown) had frontolyzed over the mountains of extreme northern California.

As the deep Low off Southeast Alaska (fig. 5) filled and moved northward, pressures rose rapidly in the Washington and British Columbia area and the ridge continued to intensify aloft. By 0030 GMT, May 30 (fig. 6) a High center of 1030 mb. was located off the Washington coast and a ridge extended southeastward through Washington and Oregon into Nevada, producing an easterly flow downslope into California from Nevada where potential temperatures were already quite high (fig. 1a).

Optimum conditions for hot weather in California were reached on May 29 and 30. At upper levels the Pacific High had increased in intensity at all levels and moved

to the northeast. Maximum northeastward displacement of the High at 500 mb. was reached at 1500 GMT May 30 (fig. 7) when it was centered just off the central California coast with a strong ridge extending northward into Southeast Alaska. Winds at this level over California from Sacramento southward had an easterly component. The easterly flow was even more pronounced at levels below 500 mb., a condition favorable for very high temperatures in the interior valleys of California.

Accompanying the increased strength of the High was a slow but continuous warming at most levels below 500 mb. throughout the California-Nevada area. In figures 8, 9, and 10 this warming is shown by soundings at 24-hour intervals over Oakland, Calif., and Ely and Las Vegas, Nev. Above the surface inversion the soundings are very similar, showing the homogeneity of the air mass covering the area. Of interest is the nearly adiabatic lapse rate at potential temperatures of 314° A to 318° A over Ely and Las Vegas (figs. 9 and 10). These values are very near the potential temperatures of the maxima at the surface in California (fig. 1). Also of interest is the very strong, low inversion shown on the Oakland sounding at 0300 GMT, May 30 (fig. 8). This sounding was taken approximately 8 hours after the occurrence of the maximum of 92° at San Francisco and illustrates the reestablishment of the sea breeze in the San Francisco Bay area.

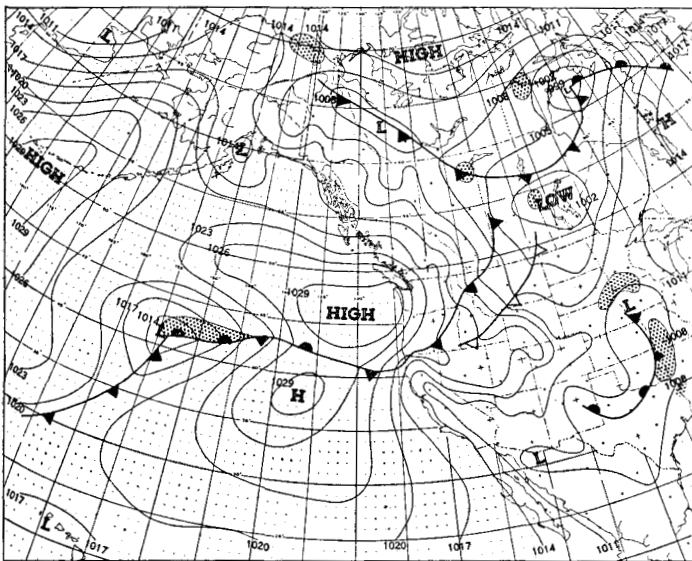


FIGURE 6.—Surface weather chart for 0030 GMT, May 30, 1950. Shading indicates areas of active precipitation.

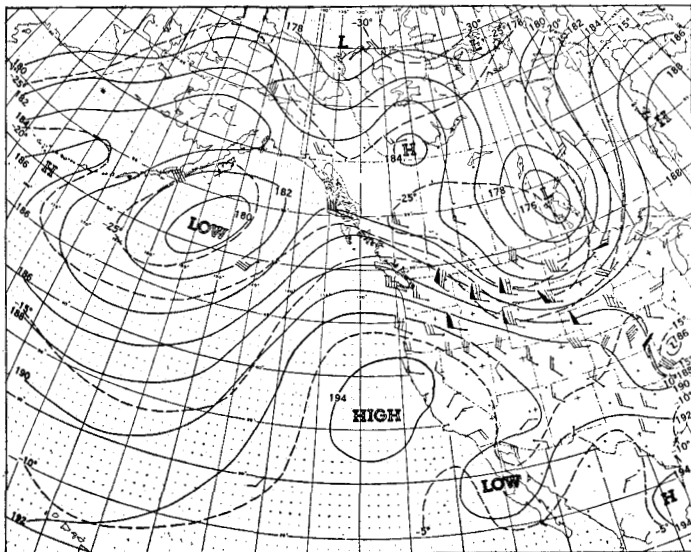


Figure 7.—500-mb. chart for 1500 GMT, May 30, 1950.

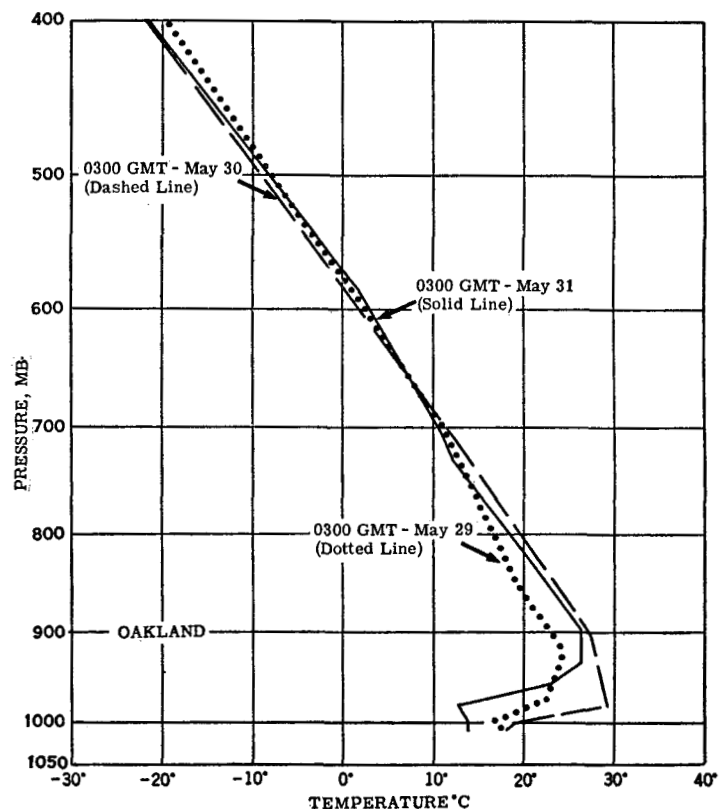


FIGURE 8.—Upper air soundings over Oakland, Calif., for 0300 GMT, May 29, 30, and 31, 1950, plotted on pseudo-adiabatic chart.

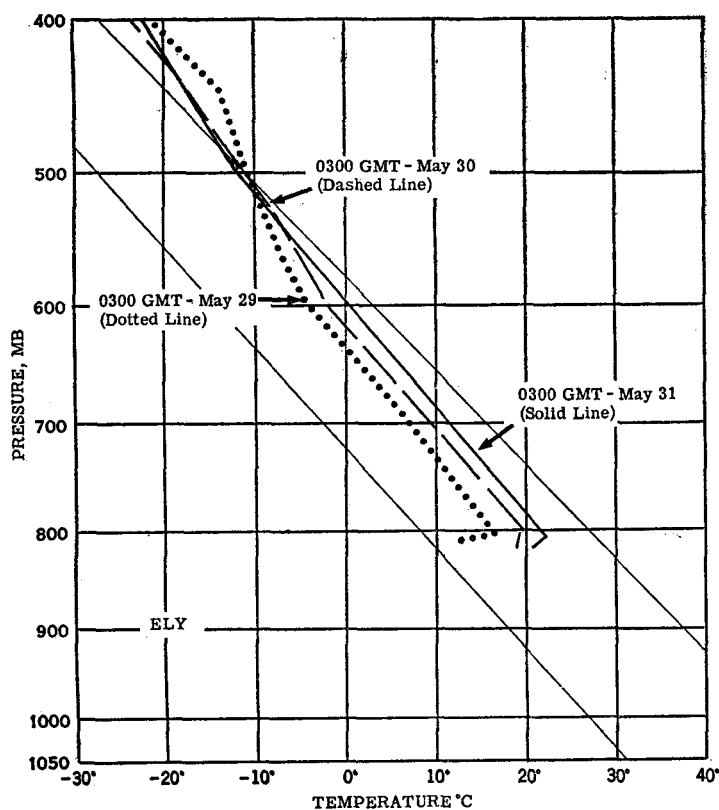


FIGURE 9.—Upper air soundings over Ely, Nev., for 0300 GMT, May 29, 30, and 31, 1950, plotted on pseudo-adiabatic chart.

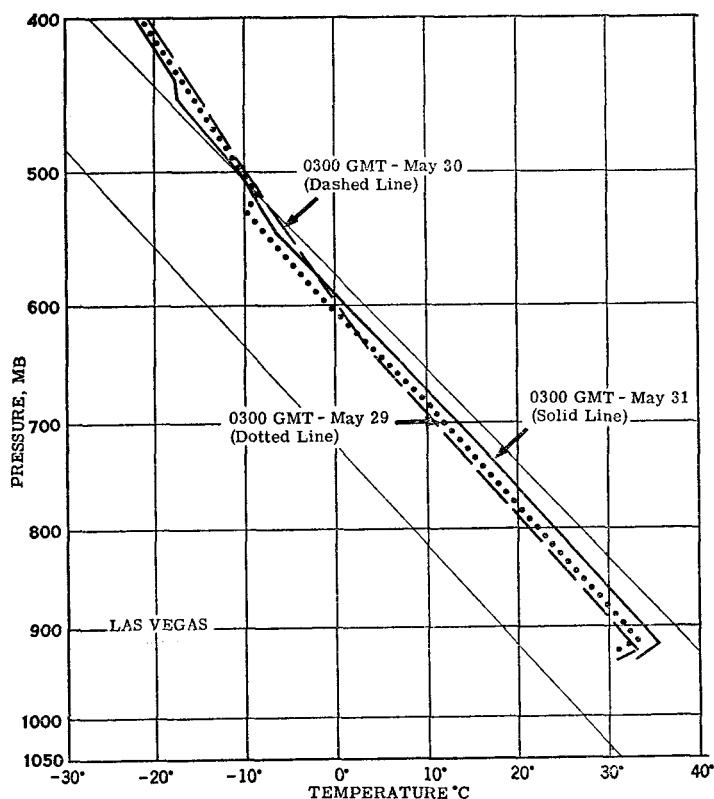


FIGURE 10.—Upper air soundings over Las Vegas, Nev., for 0300 GMT, May 29, 30, and 31, 1950 plotted on pseudo-adiabatic chart.

Maximum temperatures at the 700-mb. level were reached at 0300 GMT, May 31 (fig. 11). Temperatures between 11°C and 12°C were far above normal [1] and approached the absolute maxima [2] for that level at Ely and Oakland. The isotherms in figure 11 show temperatures to be much higher over the continent than in the portion of the High over the ocean to the west. They were also higher than any which could have resulted from horizontal advection and as previously mentioned, were evidently caused by the combined effect of strong surface heating over land and subsidence in the eastern portion of the Pacific High cell.

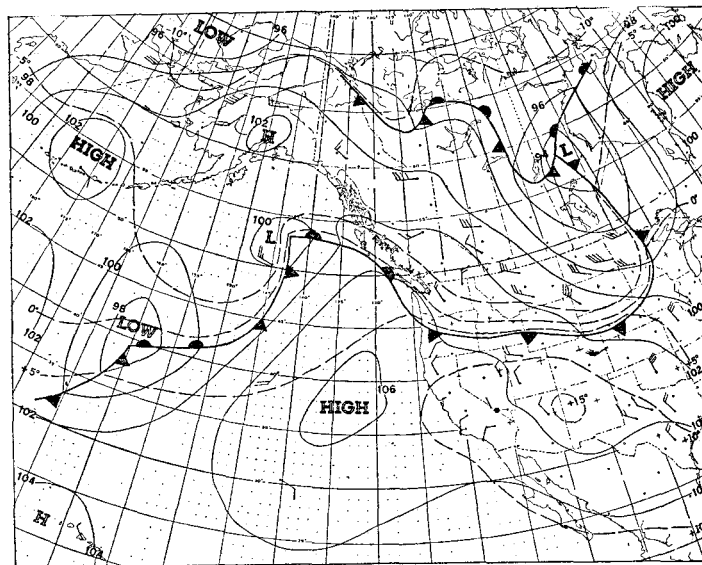


FIGURE 11.—700-mb. chart for 0300 GMT, May 31, 1950. Contours (solid lines) are labeled in hundreds of geopotential feet. Isotherms (dashed lines) are drawn for intervals of 5°C . Barbs on wind shafts are for wind speeds in knots (full barb for every 10 knots, half barb for every 5 knots and pennant for every 50 knots).

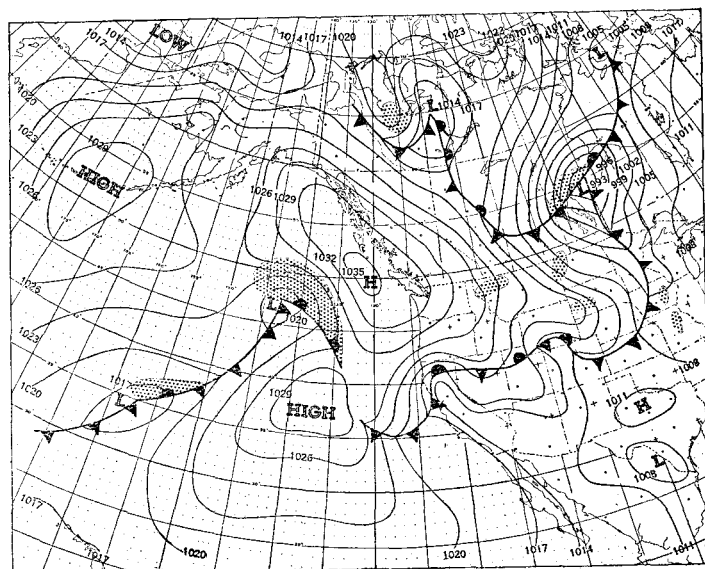


FIGURE 12.—Surface weather chart for 1830 GMT, May 30, 1950. Shading indicates areas of active precipitation.

Coincident with the building of the warm High aloft the surface High continued to increase in intensity off the Washington-British Columbia coast reaching a maximum at the center of 1036 mb. just south of Cape St. James, B. C., at 1830 GMT, May 30 (fig. 12). A pronounced ridge continued to extend southeastward into Nevada. The pressure of 1036 mb. near Cape St. James was within about 1 millibar of the highest ever recorded at that location during May.

Although figure 12 represents conditions near the time of peak temperatures in California, it also shows some indication of the breakdown of these conditions. The Low at 47° N, 143° W, while not deep, was too well marked to disappear quickly. It subsequently filled slowly, but as it approached the coast there was a rapid breakdown of the High.

By 1500 GMT, May 31 (chart not shown), the eastern and northern extension of the High at upper levels had almost entirely disappeared, and cooler air was moving

into northern California and Nevada. This flow was generally westerly at 500 mb. and northwesterly at the 700-mb. level. The maximum potential temperature chart (fig. 1) shows appreciable cooling in northern California on May 31 though many interior valley stations still reported temperatures of 100° or more. Further cooling was more gradual but by June 2 (chart not shown) the heat had moderated in all but the extreme southeast section of the State.

REFERENCES

1. U. S. Weather Bureau, "Upper Air Average Values of Temperature, Pressure, and Relative Humidity over the United States and Alaska," Washington, D. C., May 1945 (reprinted as *Technical Paper No. 6*, April 1949).
2. U. S. Weather Bureau, "Extreme Temperatures in the Upper Air," *Technical Paper No. 3*, Washington, D. C., July 1947.

